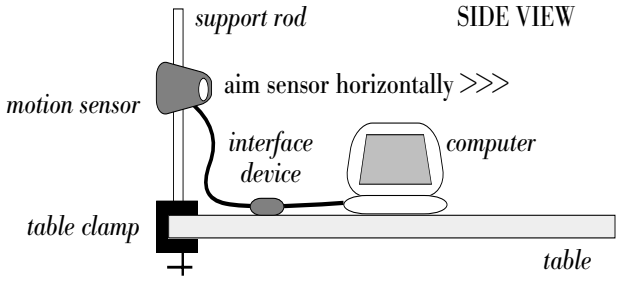
Newton's 1st Law & Resulting Motion Lab 4: Graphing Position vs. Time

Purpose

In this activity, you will investigate motion through graphs of position vs. time of your own motion drawn in real time.

Set Up

It is important that you follow the order of these instructions exactly! Use the diagram as a guide.



1. Log into a student's account on the desktop computers. Attach the ring stand support rod to the stand base and set on table.

2. Attach the motion sensor to the support rod at a height of about 4 feet from the ground. Aim it as shown in the diagrams. If available, switch the sensor to "people" or "long range" mode (as opposed to "cart" or "short range" mode). Connect the motion sensor to the interface device. (Keep excess lengths connecting wire on the table instead of letting it dangle onto the floor.)

3. Once the computer has booted up completely. Connect the interface device to the computer. (The USB cable connects to the USB port on the back of the computer)

NOTE: This activity involves the use of the computer and sensor(s). These items are very expensive and fragile. Extreme care must be taken at all times when transporting and using the computer and the sensors. Attention to the safety and security of the computers and sensors throughout the classroom (and awareness of the location of all connecting wires) must be paid at all times.

Probeware Activation

1. Open DataStudio by searching it in the magnifying glass.

2. Once DataStudio opens select Open Activity then select cancel.

3. Activate the sensor by clicking on the green "Start" button located at the upper left corner of the screen. The sensor should start clicking, and a graphical animation of the sensor should appear below the start button.

4. Allow each member of the group to experiment with the motion sensor. Stand in front of it holding a piece of pyrex-board in front of you as you move so that the sound waves will reflect off a solid object. Move toward it and away from it. Stand still. Reset the graph by clicking on the stop/start button. Each time you wish to clear the graph (between each member's turn with the sensor, for example) select the run on the left of the screen and hit the delete key. Make sure you have at least two meters to move in, and that the walking space is clear of chairs, wires, and other obstacles. As shown in the diagram above, the person walking in front of the sensor is the person watching the computer screen.

Procedure

1. REST
   a. Your location in space is typically referred to as your position. In terms of position, what does it mean for someone to be at rest?

   b. In terms of position, what does it mean to be in motion?

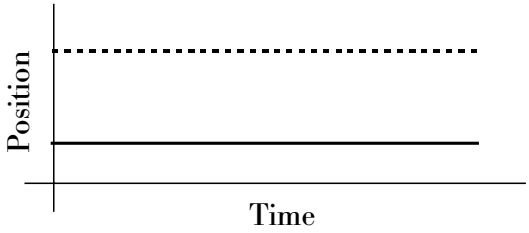
   c. How can rest and motion be distinguished using the motion sensor?
      i. Using the motion sensor, create a graph of an object rest. Sketch the graph.

      ii. Using the motion sensor, create a graph of an object in motion. Sketch the graph.

      iii. What's are similarities and differences between the two objects whose motions are depicted in the graph?

         1. Similarity

         2. Difference

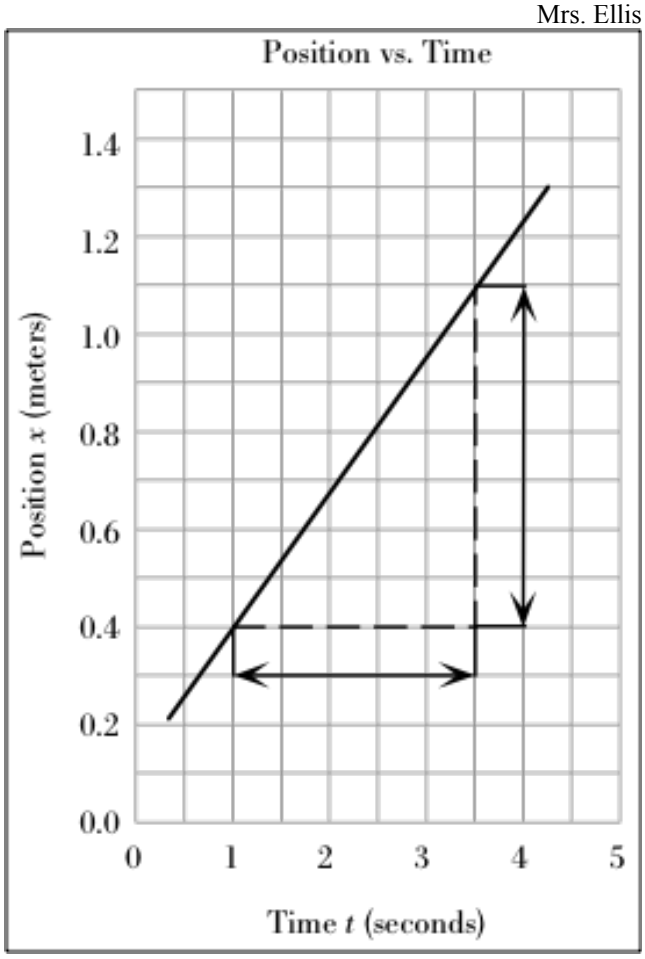


2. CONSTANT OR UNIFORM MOTION
   a. What is meant by "constant motion" or "uniform motion"?

   b. What is true about an objet's net force if constant motion occurs?

   c. Using the motion sensor, create a graph of an object in constant motion to the best of your ability. Sketch the graph.

3. THE SLOPE OF A POSITION VS. TIME GRAPH
Consider the motion plotted. A portion of the graph has been made into the hypotenuse of a right triangle.



a. What is represented by the horizontal leg of the right triangle?
   i. In variables In Units

   ii. In words

b. What is represented by the vertical leg of the right triangle?
   i. In variables In Units

   ii. In words.

c. What is represented by the slope (not the length) of the hypotenuse?
   i. In variables In Units

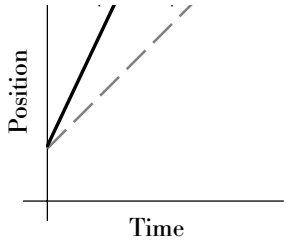
   ii. In words (do not use a one word answer but describe what the slope tells you).

d. Determine the speed of the object whose motion is shown in the graph above. Express your answer in meters per second. (Hint: The correct answer is not 1.4 m/s. Be sure to examine the scales of the axes as you make your calculation.)

GIVEN VARIABLES	EQUATION	WORK	ANSWER

4. DIFFERENT SLOPES FOR DIFFERENT FOLKS
   The dashed line represents a "standard" uniform motion. Have one group member produce the "standard" uniform motion. Have a second group member produce the solid line for each of the following examples. Compared to that standard, what kind of motion, if any, produced a position vs. time graph that has the following characteristic? Describe how the second member's motion was similar to the first member as well as identifying the differences in the motion.

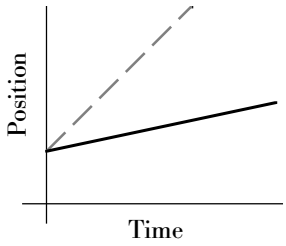
   a. a steeper slope?



Similarities

Differences

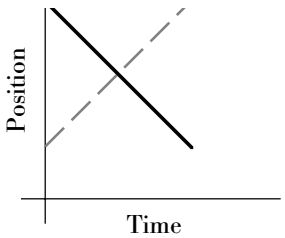
   b. a shallower slope?



Similarities

Differences

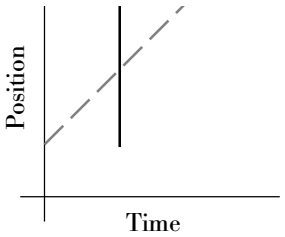
   c. a negative slope?



Similarities

Differences

   d. an undefined (or infinite) slope?



Similarities

Differences

5. MULTIPLE MOVEMENTS
   For each description below, have a group member walk the motion. Then graph the motion on the position vs. time graph provided. Indicate on each graph where the motion is at rest, towards or away.

   a. Move toward the sensor at a constant speed, stop and remain still for a second, then walk away from the sensor with the same constant speed.

   b. Starting a distance away from the sensor start at rest and remain still for a second, then walk towards the sensor then away both at the same constant speed.

   c. Move away from the sensor slowly at a constant speed, stop and remain still for a second, then walk away from the sensor with a faster constant speed then stop and rest.

   d. Provide your own description

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